INSTRUCTION MANUAL

model 129
PULSE GENERATOR

E-H RESEARCH LABORATORIES, INC.

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PRELIMINARY

INSTRUCTION MANUAL

model 129

PULSE GENERATOR

E-H RESEARCH LABORATORIES, INC.

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WARRANTY

All E-H/AMC products are warranted for a period of one year from date of delivery. These products are warranted to be free from defects in material and workmanship, suitable for normal use and service under normal conditions, and able to meet any applicable specifications accepted in writing by E-H/AMC. No claim under the warranty will be accepted unless it is made in writing to E-H/AMC immediately after discovery of defect or in any case, within one year of delivery. No other warranty, express or implied exists outside this warranty. E-H/AMC is not liable for any commercial losses or other consequential damages incurred or sustained as a result of any defective or nonconforming product. E-H/AMC's obligation with respect to losses is limited, under this warranty, at E-H/AMC's option, either to the replacement (by delivery F.O.B. Oakland, California) or repair of its manufactured products which prove to be defective or nonconforming. This warranty does not apply to any products improperly applied or used or which have been subjected to intentional or negligent misuse or accident, or which have been in any way modified by others without the express written agreement of E-H/AMC. In the event the product is returned, transportation is at customer's expense. Return of products from the factory to customer after warranty repair is at the expense of E-H/AMC.

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Figure 1-1 Model 129 Pulse Generator

SECTION 1
SPECIFICATIONS

1-1 INTRODUCTION

The purpose of this manual is to provide basic information for operation of the E-H Model 129 Pulse Generator, in the interim while a complete instruction manual is being produced.

This preliminary manual includes such essential information as performance specifications, description of controls, list of replacement parts, and schematic drawings. It will be replaced, at no charge, as soon as the full-size instruction manual for the Model 129 is printed.

Holders of this manual should complete the enclosed customer service card at once and return it so that they will be included in the distribution of the new instruction manual when it becomes available.

Section 1 of this manual contains the electrical and mechanical specifications for the instrument. Section 2 contains a description of controls. Section 3, Theory of Operation, and Section 4, Maintenance, are omitted in this preliminary manual but will, of course, be included in the full-size instruction manual. Section 5 contains the parts list and ordering information. Engineering schematics are included in the Appendix at the back of the manual.

1-2 GENERAL INFORMATION

The E-H Model 129 is a solid-state pulse generator that provides fast risetime and falltime pulses at high repetition rates. Pulse repetition frequency is variable from 10 kHz to 500 MHz – with variable pulse width, delay and output levels. Output pulse risetime and falltime is 500 ps or less.

Duty factor capability is 50%; also, output pulse waveforms may be inverted to provide an equivalent duty factor approaching 100% except at the highest pulse repetition rates where minimum pulse width limits the equivalent duty factor. The baseline offset control allows the pulse train to be adjusted off the zero reference up to 1 volt in either polarity.

A separate trigger output provides signals for triggering oscilloscopes, additional pulse generators or other test instruments. The Model 129 may be externally triggered by the single-cycle push-button, or by another pulse generator, at any repetition rate up to 250 MHz. The output pulse train can be gated by an externally supplied pulse.

The output of the Model 129 is a current source designed to work into 50 ohms. It may safely drive any lower impedance, including a short-circuit, but should not be left open-circuited unless the amplitude is set to minimum and the base-line offset is set to maximum negative offset.

1-3 SPECIFICATIONS

Pulse Repetition Frequency . . . . . 10 kHz to 500 MHz in 11 ranges, with fine control.

Output Pulse Amplitude . . . . ±200 mV to ±2 V into 50 ohms Amplitude continuously variable by 2-position coarse range switch and fine amplitude control.

Waveform Distortion . . . . . less than 7% P-P at 2 V, either polarity.

Rise and Fall Times . . . . . less than 500 ps

Pulse Width . . . . . approximately 1 ns to 50 μs continuously variable by 10-position coarse range selector and fine control.

Pulse Delay . . . . . approximately 1 ns to 50 μs continuously variable by 10-position coarse range selector and fine control.

Duty Factor . . . . . 50% maximum

Baseline Offset . . . . . -1 V to +1 V into 50 ohms, unaffected by pulse amplitude setting, continuously variable by fine control.

Output Terminating Impedance . . . . . 50 ohms

External Trigger Input . . . . . +1.5 V into 50 ohms

External Gate . . . . . synchronous gate,

3-position switch selects gated on (+1.5 V into 50 ohms), normal (ungated), or gated off (−1.5 V into 50 ohms).

Trigger Output . . . . . +0.15 V or +1.5 V into 50 ohms. switch selected.

Trigger Width . . . . . equal to 50% pulse period for all frequencies.

Single Cycle Operation . . . . . one output cycle when frequency switch set to external and front-panel pushbutton pushed.

Signal Connectors . . . . . General Radio Type 874

Power Requirements . . . . . 105-125 and 200-234 Vac, 50-60 Hz, 83 V-A.

Dimensions

. . . . . 5-7/8 in. (14.9 cm) high
. . . . . 17-3/4 in. (45 cm) wide
. . . . . 13 in. (33 cm) deep

Weight

. . . . . 25 lb (11.4 kg)

SECTION 2
OPERATING INFORMATION

2-1 USING THE MODEL 129

With a risetime of less than 500 ps, the Model 129 output pulse contains frequency components over 2 GHz. If any of the connectors, cables or attenuators used do not have flat response in excess of 2 GHz, degradation of pulse risetime will occur. Mismatch effects can also degrade the pulse slope (e.g., distortion, ringing, overshoot, etc).

Terminate the Model 129 in 50 ohms whenever possible. If the input impedance of the device or system under test is other than 50 ohms, use an impedance matching device to minimize mismatch effects. Since the deterioration of pulse risetime, due to the pulse passing through a coaxial cable, is proportional to the square of the cable length, use only a few feet of high quality cable whenever possible.

2-2 OPERATING FUNCTIONS

a. **FREQUENCY.** Selects pulse repetition frequency as determined from the internal clock or the external trigger pulse. Range extends from 10 kHz to 500 MHz in 11 ranges: 10/30/100/300 kHz; 1/3/10/30/75/150/300/500/ MHz. External from zero to 250 MHz.

b. **FINE (FREQUENCY)** Continuously variable in each range with overlap to adjacent ranges.

c. **DELAY** Selects time between trigger output and pulse output in ten ranges from approximately 1 ns to 50 μs. A fixed delay of 6 ns is added to the minimum setting on each range. Ranges are min/3/10/30/100/300 ns; 1/3/10/30/50 μs.

d. **FINE (DELAY)** Continuously variable in each range with overlap to adjacent ranges. When the frequency switch is set to either of the two highest ranges, this control is disabled.

e. **WIDTH** Selects the output pulse width from a range of 1 ns to 50 μs. Ranges are min/3/10/30/100/300 ns; 1/3/10/30/50 μs.

f. **FINE (WIDTH)** Continuously variable in each range with overlap to adjacent ranges.

g. **AMPLITUDE** Selects output pulse amplitude in two ranges, 0.2 to 0.6 V and 0.6 to 2 V into 50 ohms.

h. **FINE (AMPLITUDE)** Continuously variable in each range with overlap between ranges.

i. **POLARITY** Selects output pulse to be either positive or negative, normal or inverted.

j. **OFFSET** Continuous baseline offset adjustment of output pulse between - 1 V to + 1 V into 50 ohms regardless of polarity or amplitude settings.

k. **POWER** Controls primary power to instrument rear-panel 1-ampere slow-blow fuses are provided for 117 V 60 Hz operation.

l. **TRIGGER** Provides a positive 1.5 V or 0.15 V (selectable by + 1.5 V ——+ 0.15 V) pulse into 50 ohms. Pulse width is nominally 50% of the clock period except when using an external clock in which case it is approximately the same width as the external clock signal. The switch should be left in the + 0.15 V position when the trigger is not terminated in 50 ohms.

m. **GATE** In conjunction with the switch, (marked + 1.5 V GATED ON, NORMAL, - 1.5 V GATED OFF) allows the output pulse train to be gated on or off by an appropriate external signal. Input impedance is 50 ohms. Maximum allowable signal is ± 3 V. Risetime of the input signal should be 100 ns or faster. When the switch is in the + 1.5 V GATED ON position the output pulse train is inhibited until a + 1.5 V signal is applied to the gate input. At this time the output pulse train will begin and last for a time equal to the width of the applied signal. When the switch is in the center (normal) position the output pulse train is unaffected by the applied gate signal. Placing the switch in the - 1.5 V GATED OFF causes the output pulse train to be inhibited only for the length of time that a - 1.5 V signal is applied to the gate input.

The Model 129 allows the last pulse in a gated burst to be longer than the rest if desired. This may be accomplished by setting the width controls to exceed 50% duty cycle. In this situation all pulses but the last will be automatically limited in width but the last pulse will be determined by width control settings.

n. **EXTERNAL TRIGGER** When the FREQUENCY switch is in the EXT position an external clock signal may be applied to the + 1.5 V TRIGGER connector. Requirements are + 1.5 V into 50 ohms, ± 3 V maximum, risetime 100 ns or faster. When the frequency switch is set to any other position, this input may be used to gate off the pulse train by applying - 1.5 V.

o. **SINGLE CYCLE** Single output pulse occurs when the FREQUENCY switch is in the EXT and SINGLE CYCLE push-button is pushed and released.

SECTION 5
PARTS LIST

5-1 ORDERING INFORMATION

Replacement parts may be ordered through an E-H Representative or directly from the factory. To be certain of receiving the proper parts, always include the following information with the order:

a. Model number and serial number of the instrument on which the parts will be installed.

b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.

c. E-H part number.

The warranty and instructions for in-warranty repair of this instrument are given on page ii of this manual, opposite the Table of Contents. For factory repair, contact the Customer Service Department of E-H Research Laboratories, Inc., at the address given on the title page of this manual. Include the following information:

a. Model number and serial number of the instrument on which the work is to be performed.

b. Details concerning the nature of the malfunction; or, type of repair desired.

Shipping instructions will be sent to you promptly.

5-2 HOW TO USE THIS PARTS LIST

The parts list is divided into subsections corresponding to the physical subsections of the instrument (printed circuit boards, chassis and subassemblies, miscellaneous hardware). Component locations can be determined from the schematic diagrams; each component appears only once in the parts list. At the beginning of each subsection are listed part numbers for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to locate malfunctions to the lowest possible level of replacement part and thus avoid the time and cost involved in "over-repair".

In the component descriptions, capacitor dielectrics are abbreviated as follows: polyethylene (poly.), ceramic (cer.), printed circuit (P.C.), electrolytic (elect.) and tantalum (tant.). Resistor and potentiometer values are given in ohms; the symbol for "ohm" (Ω) has been omitted. If no material is listed, resistors may be assumed to be carbon composition; other resistor types are metal film (MF) and wire-wound (WW). An asterisk following a component value indicates that the actual value is factory-selected at time of manufacture; the listed value is nominal.

Power Supply Board

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
Complete Assembly		401-15029
C1	Cap., 100 μF/25 V, elect.,	316-00035
C2	Same as C1	
C3	Cap., 25 μF/25 V, elect.	316-00028
CR1	Diode 1N4005	376-00034
CR2	Same as CR1	
CR3	Same as CR1	
CR4	Same as CR1	
CR5	Same as CR1	
CR6	Same as CR1	
CR7	Diode, 1N914B	376-00022
CR8	Diode, 1N746A	374-00017
CR9	Diode, 1N754A	374-00025
CR10	Diode, 1N914B	376-00022
CR11	Same as CR8	
Q1	Transistor	663-11725
Q2	Transistor	663-11725
Q3	Same as Q1	
Q4	Same as Q1	
Q5	Same as Q1	
R1	Res., 1, 3W, WW	610-00069
R2	Res., 5, 10W, WW	610-00017
R3	Res., 1, 3W, WW	610-00069
R4	Res., 2, 3W, WW	610-00077
R5	Res., 2, 3W, WW	610-00077
R6	Res., 3.3k, 1/2W, 5%	596-00332
R7	Res., 430, 1/2W, 5%	596-00431
R8	Res., 470, 1/2W, 5%	596-00471
R9	Potentiometer 200	551-00039
R10	Res., 4.7k, 1/2W, 5%	596-00472
R11	Res., 6.2k, 1/2W, 5%	596-00622
R12	Res., 1.8k, 1/2W, 1%, MF	618-00017
R13	Res., 620, 1/2W, 5%	596-00621
R14	Res., 3k, 1/2W, 5%	596-00302

(A)

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
R15	Res., 100, 1/2W, 5%	596-00101
R16	Res., 820, 1/2W, 5%	596-00821
R17	Res., 2k, 1/2W, 1%, MF	618-00005

Current Source Board

Complete Assembly		402-15032
C1	Cap., 0.001 μF, 1k V, 10%, cer.	311-00010
C2	Same as C1	
C3	Same as C1	
CR1	Diode, 1N270	376-00031
CR3	Diode	374-12529
Q1	Transistor, 1N3904	663-00070
Q2	Transistor, 2N3906	663-00071
Q3	Same as Q2	
Q4	Same as Q1	
R1	Res., 1.5k, 1/2W, 1% MF,	618-00014
R2	Potentiometer, 200	551-00053
R3	Res., 499, 1/2W, 1%, MF	618-00001
R4	Res., 1.58k, 1/2W, 1%, MF	618-00103
R5	Res., 215, 1/2W, 1%, MF	618-00040
R6	Same as R2	
R7	Res., 619, 1/2W, 1%, MF	618-00085
R8	Res., 3.01k, 1/2W, 1%, MF	618-00018
R9	Same as R1	
R10	Same as R5	
R11	Res., 383, 1/2W, 1%, MF	618-00104
R12	Res., 2k, 1/4W, 5%	595-00202

Output Board

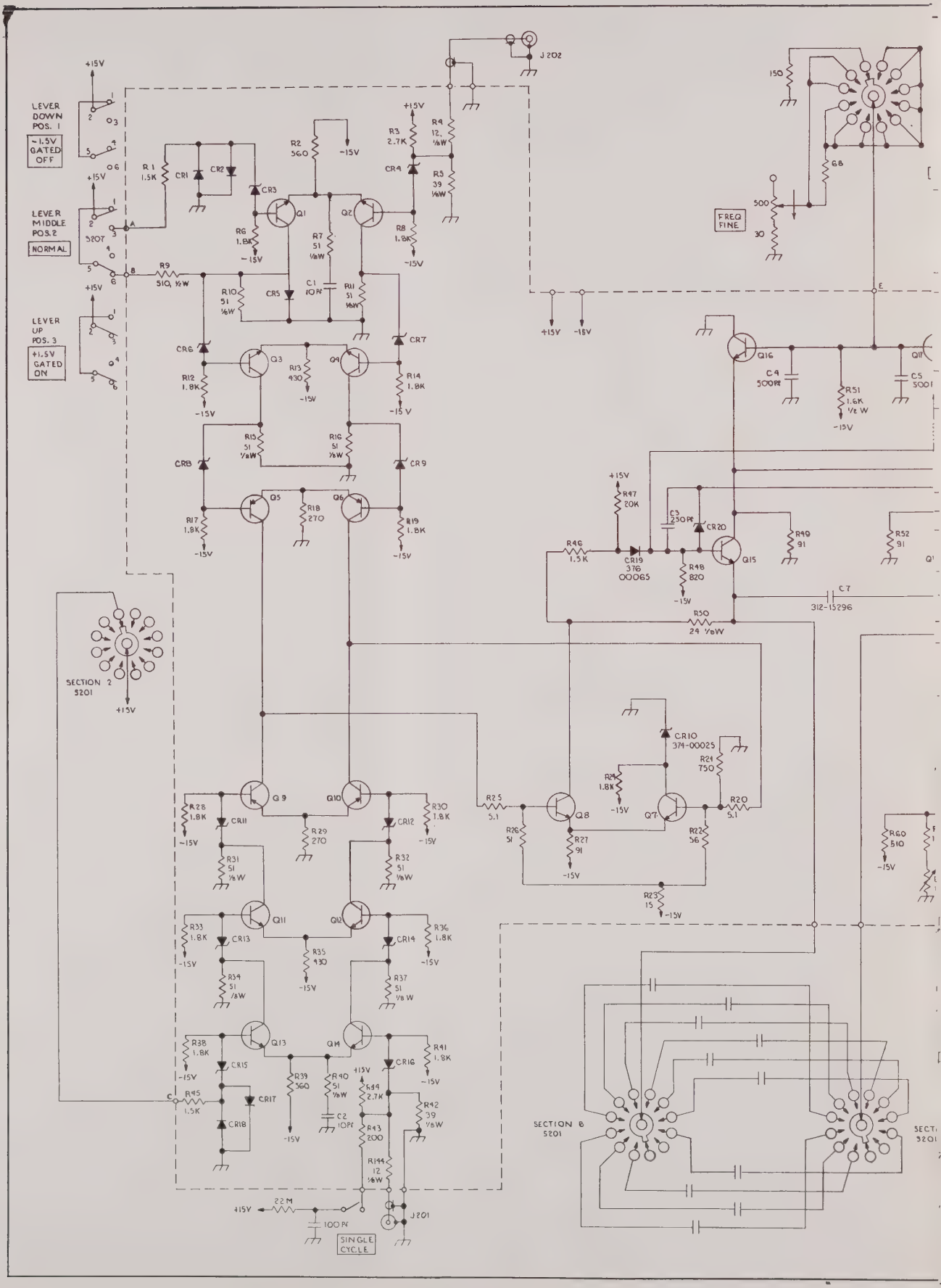
Complete Assembly		402-15038
C1	Cap., 220 pF, Disc., Hi-Q	311-00075
C2	Same as C1	
C3	Same as C1	
C4	Same as C1	
C5	Same as C1	
C6	Same as C1	
C7	Same as C1	
C8	Same as C1	
C9	Cap., 100 pF, Disc., Hi-Q	311-00064
CR1	Diode, 1N746A, Matched Pair,	374-11797
CR2	Same as CR1	
CR3	Same as CR1	
CR4	Same as CR1	
CR5	Same as CR1	
CR6	Same as CR1	
CR7	Same as CR1	
CR8	Same as CR1	
CR9	Same as CR1	
CR10	Same as CR1	
L1	Choke	335-15280
Q1	Transistor, 11778, Matched pair	663-15300
Q2	Same as Q1	
Q3	Same as Q1	
Q4	Same as Q1	
Q5	Same as Q1	
Q6	Same as Q1	
Q7	Same as Q1	
Q8	Same as Q1	
Q9	Same as Q1	
Q10	Same as Q1	
R1	Res., 51, 1/8W, 5%	594-00510
R2	Same as R1	
R3	Res., 2.4k, 1/4W, 5%	595-00242
R4	Same as R3	
R5	Res., 51, 1/4W, 5%	595-00510
R6	Res., 300, 1/2W, 5%	596-00301
R7	Same as R5	
R9	Same as R3	
R10	Res., 47, 1/4W, 5%	595-00470
R11	Res., 240, 1/2W, 5%	596-00241
R12	Same as R10	
R13	Same as R3	
R14	Same as R3	
R15	Res., 43, 1/4W, 5%	595-00430
R16	Res., 200, 3W, WW	
R17	Same as R15	
R18	Same as R3	
R19	Same as R11	
R20	Same as R3	
R21	Res., 30, 1/4W, 5%,	595-00300
R22	Same as R21	
R23	Res., 820, 1/4W, 5%	595-00821
R24	Res., 130, 1/2W, 5%	596-00131
R25	Res., 91, 1/4W, 5%	595-00910
R26	Same as R23	
R27	Res., 510, 1/4W, 5%	595-00511
R28	Res., 750, 1/4W, 5%	595-00751

Timing Board

Complete Assembly (Wire-In)		402-15035
C1	Cap., 10pF, 500V, 10%, cer.	311-00065
C2	Same as CR1	
C3	Cap., 250pF Undipped	312-00005
C4	Cap., 500pF, 500V, 10%, cer.	311-00073
C5	Same as C4	
C6	Same as C3	
C7	Coupling Capacitor	312-15296
C8	Cap., 50pF, 500V, 10%, cer.	311-00066
C9	Same as C4	
C10	Same as C1	
C11	Same as C1	
C12	Cap., 22pF, 500V, 10%, cer.	311-00072
C13	Same as C4	
C14	Same as C12	
C15	Same as C4	
C16	Cap., 5pF/kV, 10%, cer.	311-00018
C17	Cap., 20pF, 1kV, 10% cer.	311-00002
C18	Cap., 120pF, 1kV, 10% cer.	311-00077
C19	Cap., 500pF, 1kV, 10%, cer.	311-00009
C20	Cap., 0.001μF/lkV, 10%, cer.	311-00033
C21	Cap., 0.005μF/200V, 5%,	
C22	Cap., 0.015μF/200V, 5%,	320-00031
C23	Cap., 0.05μF/200V, 5%,	320-00005
C24	Cap., 0.15pF,	
C25	Cap., 0.47μF/100V, 1%,	320-00041
C26	Cap., 33pF, 500V, 10%, cer.	311-00068

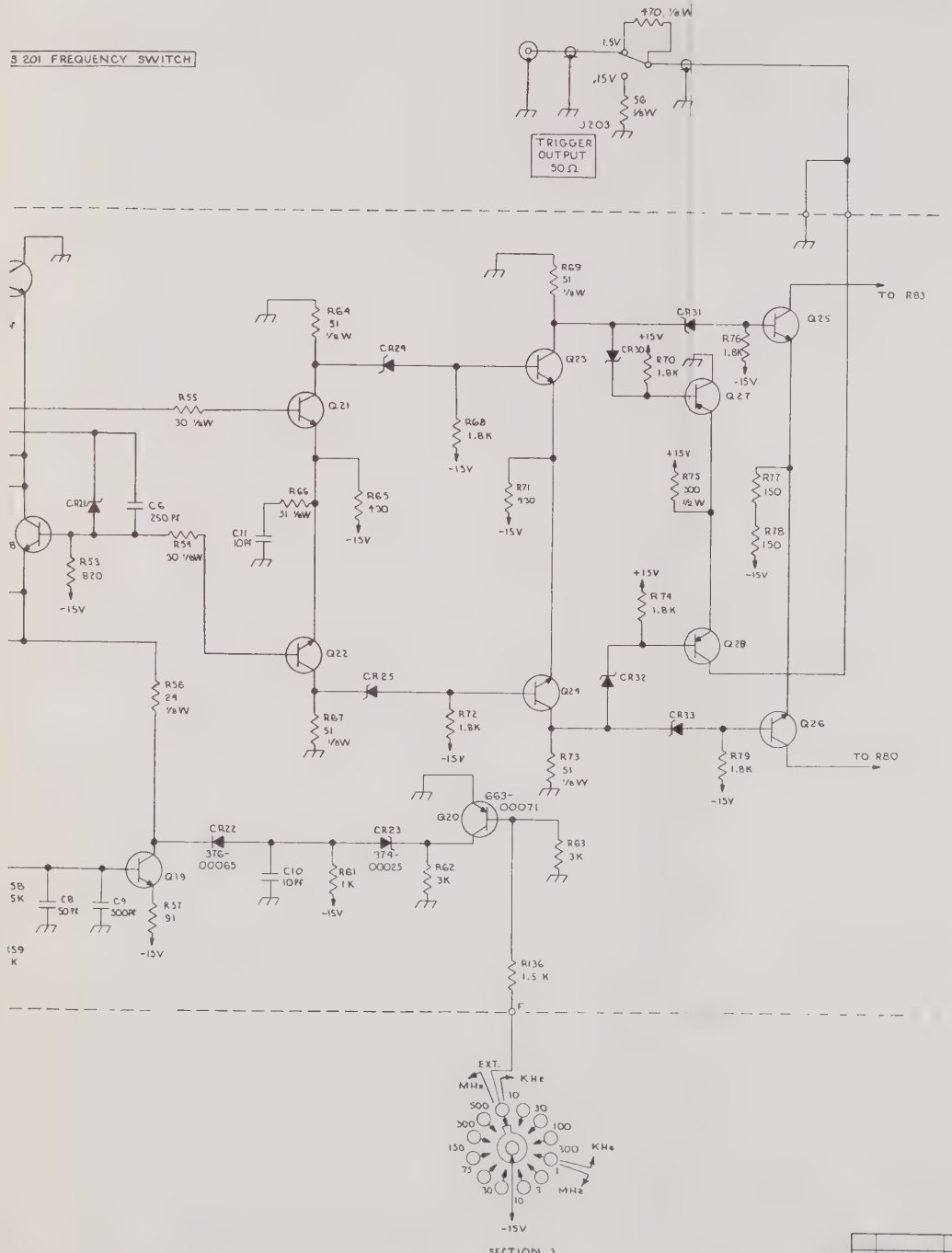
CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
C27	Same as C19	
C28	Same as C16	
C29	Cap., 30pF, 1kV, 10%, cer.	311-00005
C30	Cap., 150pF, cer.	
C31	Cap., 620pF, 500V, 5%, poly..	326-00013
C32	Cap., 0.002μF/500V, 10%, cer.	311-00080
C33	Cap., 0.006μF/200V, 5%,	
C34	Cap., 0.02μF/200V, 5%,	320-00022
C35	Cap., 0.06μF/200V, 5%,	320-00023
C36	Cap., 0.2μF/200V, 5%,	320-00024
C37	Cap., 0.6μF/200V, 5%,	320-00025
CR1	Diode	376-11764
CR2	Same as CR1	
CR3	Diode	374-12529
CR4	Same as CR3	
CR5	Same as CR1	
CR6	Same as CR3	
CR7	Same as CR3	
CR8	Same as CR3	
CR9	Same as CR3	
CR10	Diode, 1N754A	374-00025
CR11	Same as CR3	
CR12	Same as CR3	
CR13	Same as CR3	
CR14	Same as CR3	
CR15	Same as CR3	
CR16	Same as CR3	
CR17	Same as CR1	
CR18	Same as CR1	
CR19	Diode	376-00065
CR20	Same as CR3	
CR21	Same as CR3	
CR22	Same as CR19	
CR23	Same as CR10	
CR24	Same as CR3	
CR25	Same as CR3	
CR26	Not used	
CR27	Not used	
CR28	Not used	
CR29	Not used	
CR30	Same as CR3	
CR31	Same as CR3	
CR32	Same as CR3	
CR33	Same as CR3	
CR34	Same as CR19	
CR35	Same as CR19	
CR36	Diode	374-00019
CR37	Same as CR3	
CR38	Same as CR3	
CR39	Same as CR3	
CR40	Same as CR3	
CR41	Same as CR19	
CR42	Same as CR19	
CR43	Same as CR36	
CR44	Same as CR3	
CR45	Same as CR3	
CR46	Same as CR1	
CR47	Same as CR1	
CR48	Same as CR1	
CR49	Same as CR1	
CR50	Same as CR1	
CR51	Same as CR1	
Q1	Transistor NPN	663-11778
Q2	Same as Q1	
Q3	Same as Q1	
Q4	Same as Q1	
Q5	Transistor, Micro Tee PNP	663-12528
Q6	Same as Q5	
Q7	Same as Q1	
Q8	Same as Q1	
Q9	Same as Q5	
Q10	Same as Q5	
Q11	Same as Q1	
Q12	Same as Q1	
Q13	Same as Q1	
Q14	Same as Q1	
Q15	Same as Q1	
Q16	Same as Q1	
Q17	Same as Q1	
Q18	Same as Q1	
Q19	Same as Q1	
Q20	Transistor, 2N3906	663-00071
Q21	Same as Q1	
Q22	Same as Q1	
Q23	Same as Q1	
Q24	Same as Q1	
Q25	Same as Q1	
Q26	Same as Q1	
Q27	Same as Q5	
Q28	Same as Q5	
Q29	Same as Q5	
Q30	Same as Q5	
Q31	Same as Q1	
Q32	Transistor, 2N3904	663-00070
Q33	Same as Q1	
Q34	Same as Q1	
Q35	Same as Q1	
Q36	Same as Q1	
Q37	Same as Q1	
Q38	Same as Q1	
Q39	Same as Q1	
Q40	Same as Q5	
Q41	Same as Q32	
Q42	Same as Q5	
Q43	Same as Q1	
Q44	Same as Q1	
Q45	Same as Q1	
Q46	Same as Q1	
Q47	Same as Q1	
Q48	Same as Q1	
Q49	Same as Q32	
Q50	Same as Q32	
R1	Res., 1.5k, 1/4W, 5%	595-00152
R2	Res., 560, 1/4W, 5%	595-00561
R3	Res., 2.7k, 1/4W, 5%	595-00272
R4	Res., 12, 1/8W, 5%	
R5	Res., 39, 1/8W, 5%	594-00390
R6	Res., 1.8k, 1/4W, 5%	595-00182
R7	Res., 51, 1/8W, 5%	594-00510
R8	Not used	
R9	Res., 510, 1/2W, 5%	596-00511
R10	Same as R7	
R11	Same as R7	
R12	Same as R6	
R13	Res., 430, 1/4W, 5%	595-00431
R14	Same as R6	
R15	Not used	
R16	Same as R7	
R17	Same as R6	

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
R18	Res., 270, 1/4W, 5%	595-00271
R19	Same as R6	
R20	Res., 5.1, 1/4W, 5%	595-00051
R21	Res., 750, 1/4W, 5%	595-00751
R22	Res., 56, 1/4W, 5%	595-00560
R23	Res., 15, 1/4W, 5%	595-00150
R24	Same as R6	
R25	Same as R20	
R26	Same as R7	
R27	Res., 91, 1/4W, 5%	595-00910
R28	Same as R6	
R29	Same as R18	
R30	Same as R6	
R31	Same as R7	
R32	Same as R7	
R33	Same as R6	
R34	Same as R7	
R35	Same as R13	
R36	Same as R6	
R37	Same as R7	
R38	Same as R6	
R39	Same as R2	
R40	Same as R7	
R41	Same as R6	
R42	Same as R5	
R43	Res., 200, 1/4W, 5%	595-00201
R44	Not used	
R45	Same as R1	
R46	Same as R1	
R47	Res., 20k, 1/4W, 5%	595-00203
R48	Res., 820, 1/4W, 5%	595-00821
R49	Same as R27	
R50	Res., 24, 1/8W, 5%	594-00240
R51	Res., 1.6k, 1/2W, 5%	596-00162
R52	Same as R27	
R53	Same as R48	
R54	Res., 30, 1/8W, 5%	
R55	Same as R54	
R56	Same as R50	
R57	Same as R27	
R58	Same as R1	
R59	Res., Variable 1k	551-00040
R60	Res., 510, 1/4W, 5%,	595-00511
R61	Res., lk, 1/4W, 5%	595-00102
R62	Res., 3k, 1/4W, 5%	595-00302
R63	Same as R62	
R64	Same as R7	
R65	Same as R13	
R66	Same as R7	
R67	Same as R7	
R68	Same as R6	
R69	Same as R7	
R70	Same as R6	
R71	Same as R13	
R72	Same as R6	
R73	Same as R7	
R74	Same as R6	
R75	Res., 300, 1/2W, 5%	596-00301
R76	Same as R6	
R77	Res., 150, 1/4W, 5%	595-00151
R78	Same as R77	
R79	Same as R6	
R80	Same as R7	
R81	Same as R21	
R82	Res., 7.5k, 1/4W, 5%	595-00752
R83	Same as R50	
R84	Res., 68, 1/4W, 5%	595-00680
R85	Same as R7	
R86	Res., 360, 1/2W, 5%	596-00361
R87	Same as R7	
R88	Same as R54	
R89	Same as R7	
R90	Same as R13	
R91	Same as R54	
R92	Same as R7	
R93	Same as R6	
R94	Same as R7	
R95	Same as R6	
R96	Same as R7	
R97	Same as R13	
R98	Same as R7	
R99	Same as R6	
R100	Same as R77	
R101	Same as R77	
R102	Same as R6	
R103	Same as R5	
R104	Res., 200, 1/8W, 5%	594-00201
R105	Not used	
R106	Not used	
R107	Res., 249, 1/4W, 1%,MF	617-00004
R108	Same as R82	
R109	Res., 24, 1/4W, 5%	595-00240
R110	Same as R84	
R111	Same as R21	
R112	Same as R5	
R113	Res., 5.1k, 1/4W, 5%	595-00512
R114	Res., 1k, 1/4W, 1%,MF	617-00002
R115	Same as R107	
R116	Same as R54	
R117	Same as R7	
R118	Same as R7	
R119	Same as R86	
R120	Same as R13	
R121	Same as R7	
R122	Same as R6	
R123	Same as R7	
R124	Same as R6	
R125	Res., 10, 1/8W, 5%	594-00100
R126	Res., 470, 1/4W, 5%	595-00471
R127	Res., 4.7k, 1/4W, 5%	595-00472
R128	Same as R6	
R129	Same as R62	
R130	Same as R126	
R131	Same as R127	
R132	Same as R62	
R133	Same as R6	
R134	Same as R125	
R135	Same as R54	
R136	Same as R1	


LEVER DOWN POS. 1
-1.5V GATED OFF
LEVER MIDDLE POS.2
NORMAL
LEVER UP POS. 3
+1.5V GATED ON
+15V
-15V
J202
R1 1.5K
CR1
CR2
CR3
R2 560
R3 2.7K
R4 12, 1/8W
CR4
R5 39 1/6W
Q1
Q2
R6 1.8K
R7 51 1/8W
R8 1.8K
R9 510, 1/2W
R10 51 1/6W
CR5
C1 10PF
R11 51 1/6W
CR6
CR7
Q3
Q4
R12 1.8K
R13 430
R14 1.8K
R15 51 1/8W
R16 51 1/8W
CR8
CR9
Q5
Q6
R17 1.8K
R18 270
R19 1.8K
SECTION 2 S201
FREQ FINE
150
68
500
30
Q16
Q17
C4 500PF
R51 1.6K 1/2 W
C5 5001
R47 20K
C3 250PF
CR20
R46 1.5K
CR19 376 00065
Q15
R48 820
R49 91
R52 91
C7 312-15296
R50 24 1/8W
CR10 374-00025
R24 750
R21 1.8K
Q7
Q8
R25 5.1
R20 5.1
R26 51
R27 91
R22 56
R23 15
R28 1.8K
CR11
CR12
R30 1.8K
R29 270
R31 51 1/8W
R32 51 1/8W
Q9
Q10
Q11
Q12
R33 1.8K
CR13
CR14
R36 1.8K
R35 430
R34 51 1/8W
R37 51 1/8 W
Q13
Q14
R38 1.8K
CR15
CR16
R41 1.8K
R39 560
R40 51 1/8W
R44 2.7K
R42 39 1/8W
CR17
CR18
R45 1.5K
C2 10PF
R43 200
R144 12 1/8W
22 M
100 PF
J201
SINGLE CYCLE
R60 510
SECTION 6 S201
SECTION 3201

SECTION 1
S201

S 201 FREQUENCY SWITCH



SECTION 3
S 204
(TYP.)

REVISIONS						
ITEM	REVISION	DATE	DRAWN	CHK'D	APP'D	ECO
A	ORIG. ISSUE	~	~	~	~	~

A
F-140-15036

ITEM NO	PART NO	DESCRIPTION	QTY

MATERIAL LIST

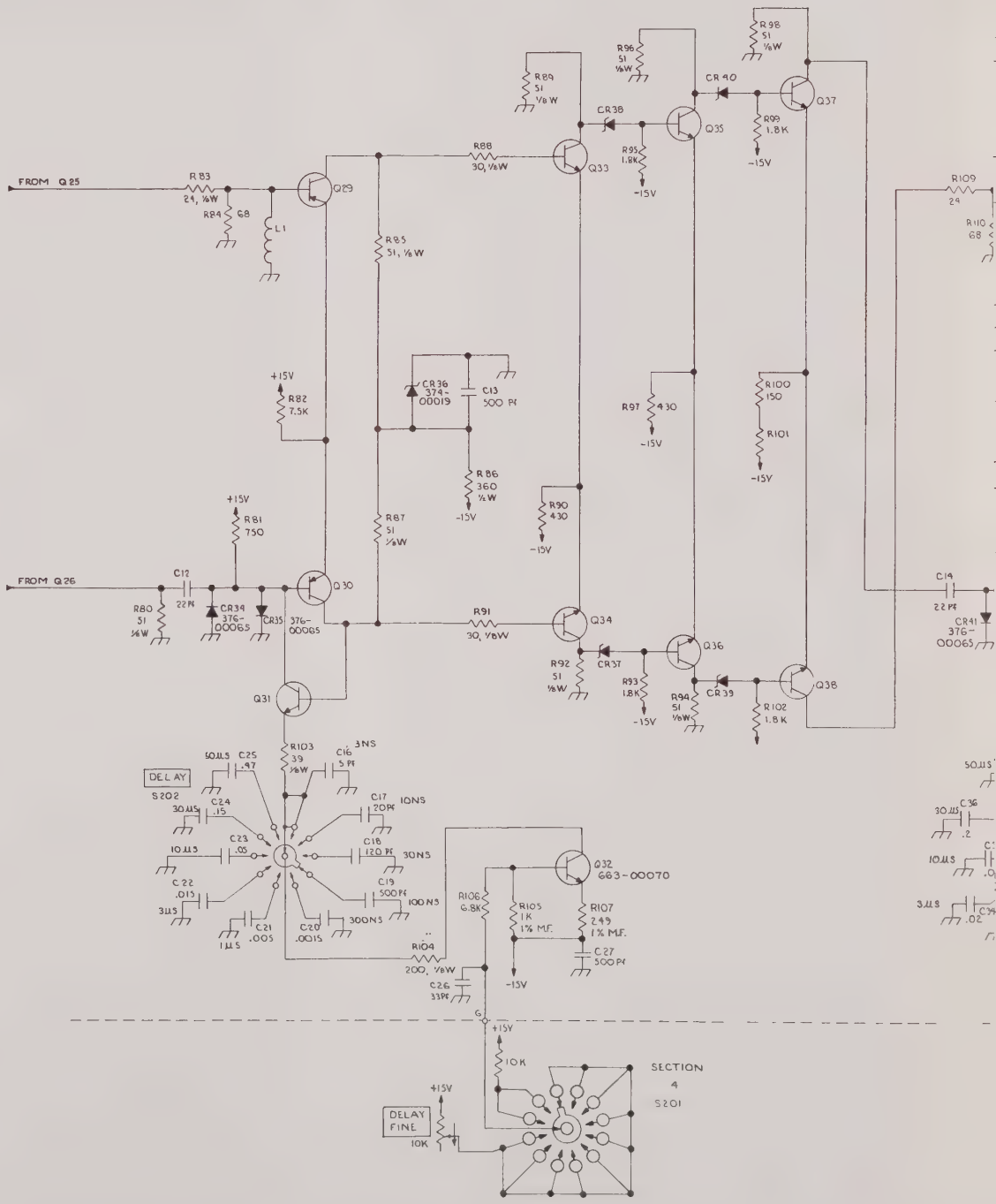
PROPRIETARY INFORMATION
NO INFORMATION GIVEN HEREIN MAY BE DISCLOSED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.

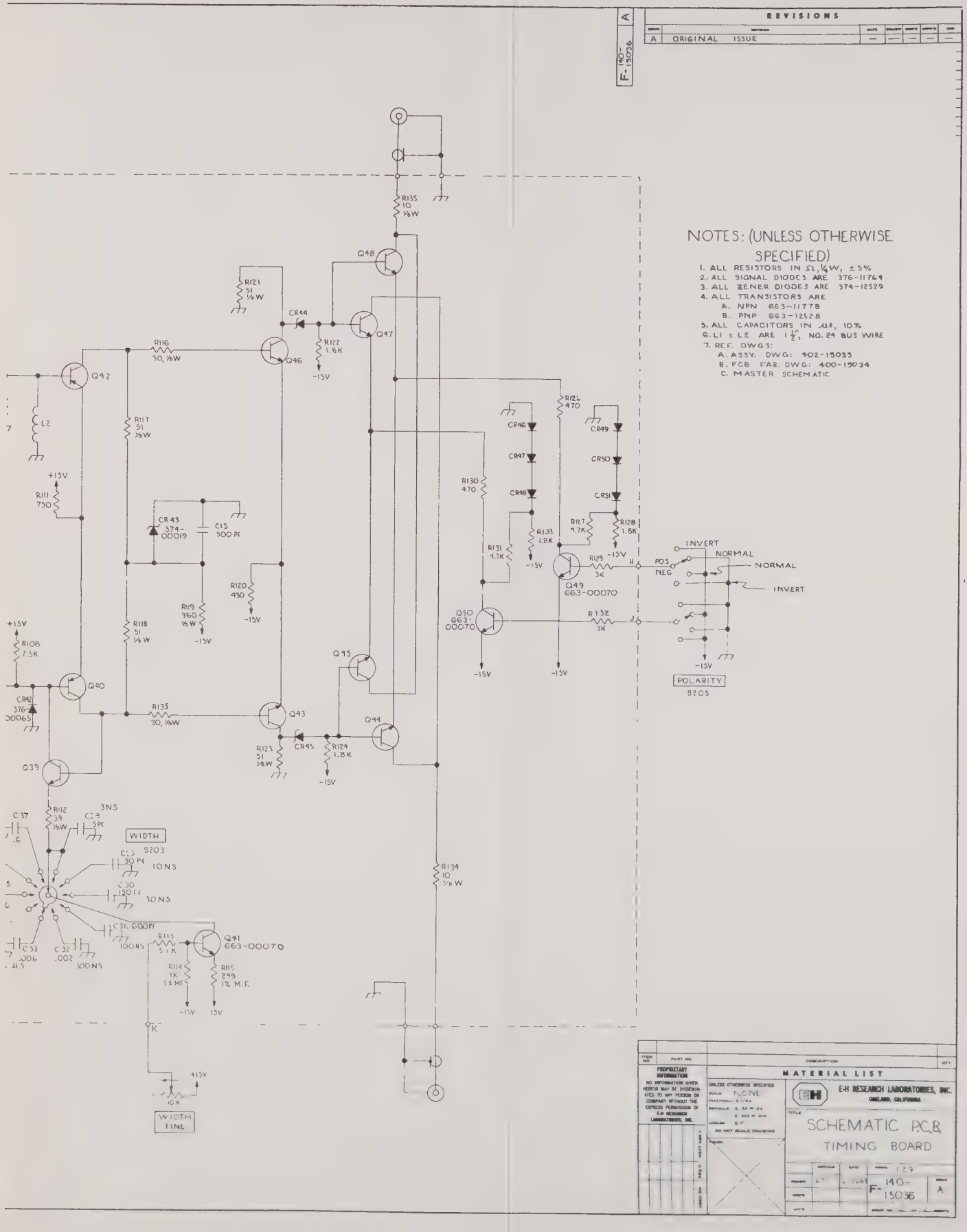
UNLESS OTHERWISE SPECIFIED
SCALE NONE
DO NOT SCALE DRAWING

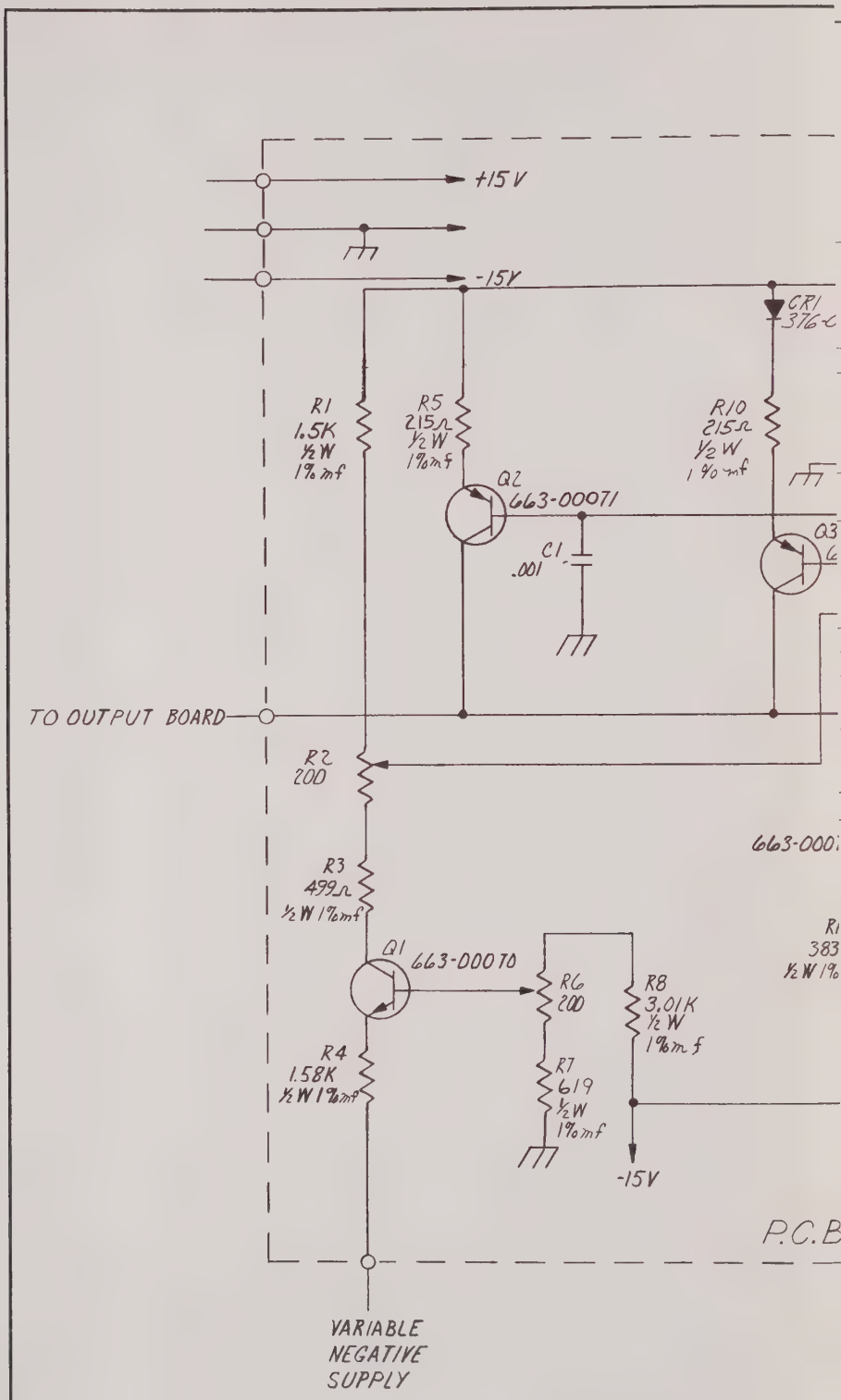
E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE
SCHEMATIC PC.B
TIMING BOARD

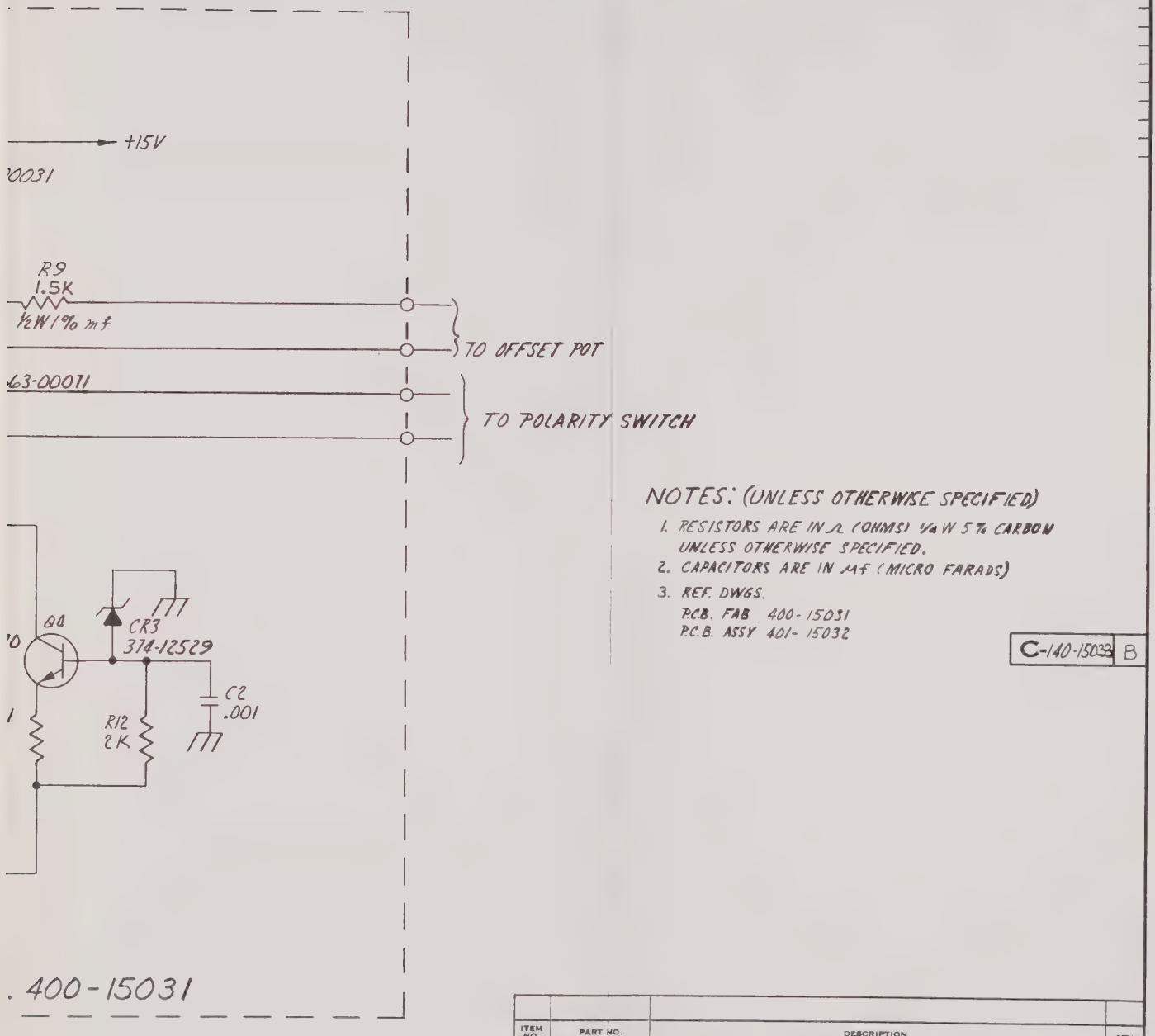
DRAWN	DATE	SIZE
RTS	6/20/69	129
		F-140-15036 A


FROM Q25
R83
24, ⅛W
R84
68
L1
Q29
R88
30, ⅛W
Q33
R89
51
⅛W
R96
51
⅛W
R98
51
⅛W
CR40
Q37
CR38
Q35
R99
1.8K
-15V
R95
1.8K
-15V
R85
51, ⅛W
+15V
R82
7.5K
CR36
374-
00019
C13
500 PF
R86
360
½W
-15V
R97
430
-15V
R100
150
R101
-15V
R109
29
R110
68
+15V
R81
750
R87
51
⅛W
R90
430
-15V
FROM Q26
C12
22PF
R80
51
⅛W
CR34
376-
00065
CR35
376-
00065
Q30
R91
30, ½W
Q34
C14
22 PF
CR41
376-
00065
R92
51
⅛W
CR37
R93
1.8K
-15V
Q36
R94
51
½W
CR39
Q38
R102
1.8K
Q31
R103
39
⅛W
C16
5 PF
3NS
50µs
C25
.47
DELAY
S202
C24
.15
30µs
C17
20PF
10NS
C23
.05
10µs
C18
120 PF
30NS
C22
.015
3µs
C19
500PF
100NS
C21
.005
1µs
C20
.00315
300NS
R104
200, ⅛W
C26
33PF
Q32
663-00070
R106
6.8K
R105
1K
1% MF.
R107
2.49
1% MF.
C27
500 PF
-15V
G
+15V
10K
SECTION
4
S201
+15V
DELAY
FINE
10K
50µs
C36
.2
30µs
10µs
3µs
C34
.02


REVISIONS
A ORIGINAL ISSUE
F-140-15036 A
NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTORS IN Ω, ¼W, ±5%
2. ALL SIGNAL DIODES ARE 376-11764
3. ALL ZENER DIODES ARE 374-12529
4. ALL TRANSISTORS ARE
A. NPN 663-11778
B. PNP 663-12528
5. ALL CAPACITORS IN μf, 10%
6. L1 & L2 ARE 1½", NO. 24 BUS WIRE
7. REF. DWGS:
A. ASSY. DWG: 402-15035
B. PCB FAB. DWG: 400-15034
C. MASTER SCHEMATIC
R135 10 ⅛W
Q48
R121 51 ⅛W
CR44
Q47
R116 30, ⅛W
Q46
R122 1.8K
-15V
Q42
L2
R117 51 ⅛W
+15V
R111 750
CR43 374-00019
C15 500 PF
R120 430
R119 360 ½W
R118 51 ⅛W
R108 7.5K
Q40
CR42 376-00065
R135 30, ⅛W
Q43
Q45
Q44
CR45
R123 51 ⅛W
R124 1.8K
Q39
R112 39 ⅛W
C37
C38 5PF
WIDTH
S203
C35 50 PF
10NS
C30 1500 PF
30NS
C31 600PF
100NS
C33 .006
C32 .002
300NS
R113 5.1K
Q41 663-00070
R114 1K 1% MF
R115 299 1% M.F.
-15V
15V
K
+15V
10K
WIDTH FINE
R134 10 ⅛W
R125 470
CR46
CR47
CR48
CR49
CR50
CR51
R130 470
R131 9.1K
R133 1.8K
R127 9.1K
R128 1.8K
Q49 663-00070
R129 3K
H
Q50 663-00070
R132 3K
J
INVERT
NORMAL
POS
NEG
POLARITY
920S
MATERIAL LIST
PROPRIETARY INFORMATION
UNLESS OTHERWISE SPECIFIED
NONE
DO NOT SCALE DRAWING
E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA
SCHEMATIC P.C.B.
TIMING BOARD
F-140-15036 A


+15 V
-15V
CR1
376-C
R1
1.5K
½W
1% mf
R5
215Ω
½W
1% mf
R10
215Ω
½W
1% mf
Q2
663-00071
C1
.001
Q3
TO OUTPUT BOARD
R2
200
663-0007
R3
499Ω
½W 1% mf
Q1
663-00070
R6
200
R8
3.01K
½W
1% mf
R4
1.58K
½W 1% mf
R7
619
½W
1% mf
-15V
P.C.B
VARIABLE
NEGATIVE
SUPPLY

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APPV'D	ECO
A	ORIGINAL RELEASE	—	—	—	—	—
B	R7 WAS 665 Ω	7-30-69	DS	GAG	[illegible]	DCN 49



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. RESISTORS ARE IN Ω (OHMS) ¼W 5% CARBON UNLESS OTHERWISE SPECIFIED.
2. CAPACITORS ARE IN μf (MICRO FARADS)
3. REF. DWGS.
   P.C.B. FAB 400-15031
   P.C.B. ASSY 401-15032

C-140-15033 B

ITEM NO.	PART NO.	DESCRIPTION	QTY

MATERIAL LIST

PROPRIETARY INFORMATION
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.

UNLESS OTHERWISE SPECIFIED
SCALE
FRACTIONAL ± 1/64
DECIMALS ± .XX = 03
± .XXX = 010
ANGLES ± 1°
DO NOT SCALE DRAWING
FINISH:

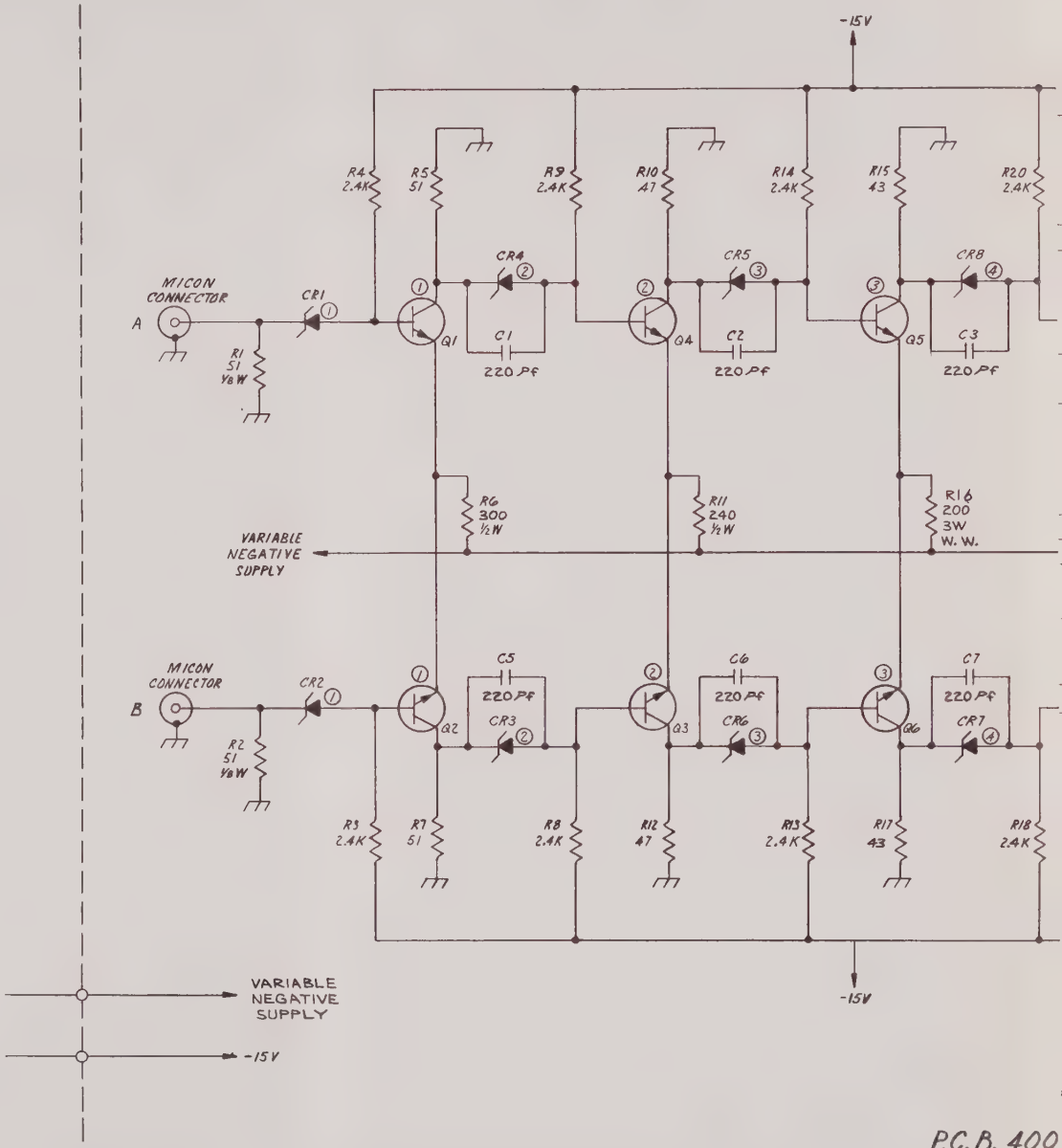
NEXT ASS'Y
REQ'D
USED ON 629

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

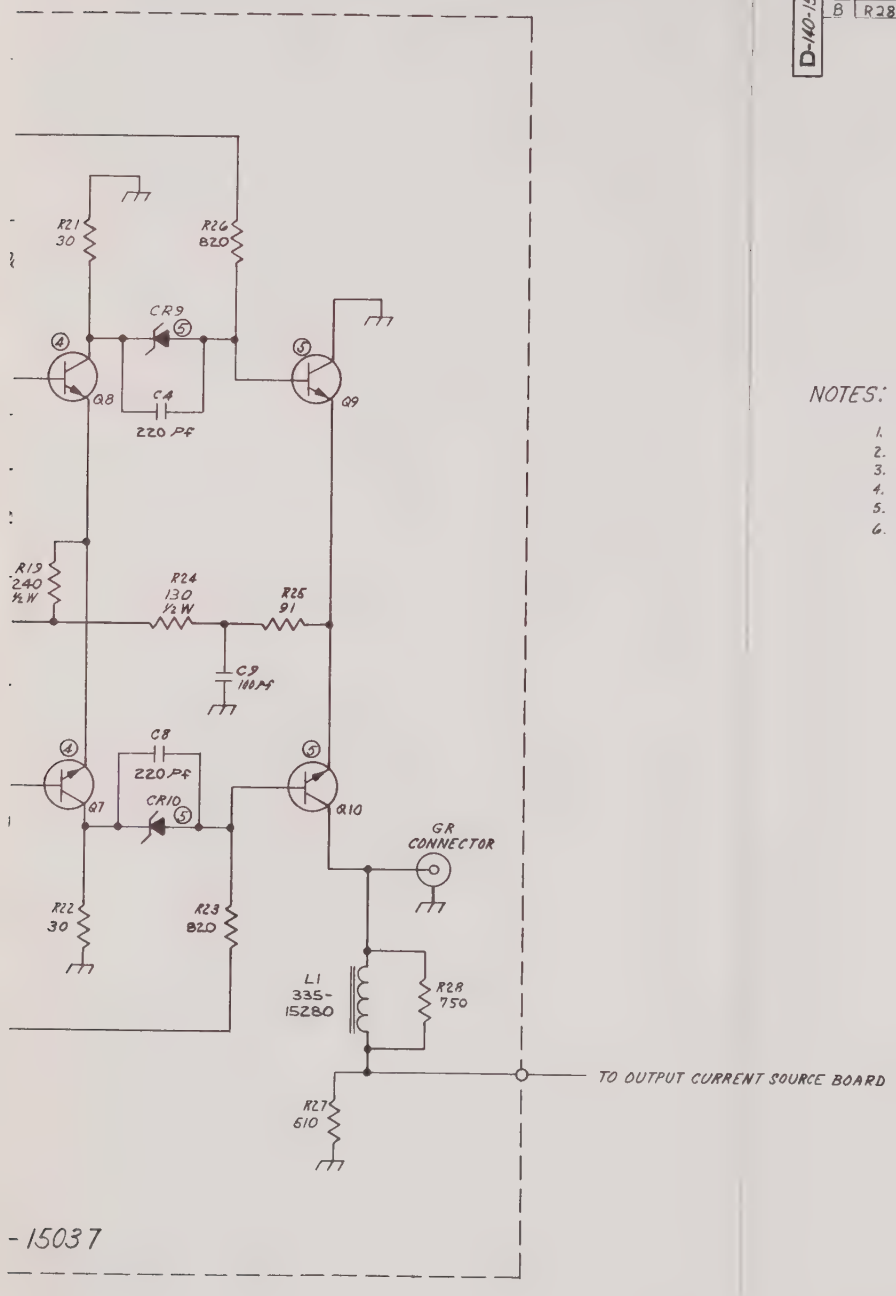
TITLE
SCHEMATIC
OUTPUT CURRENT SOURCE
BOARD

	INITIALS	DATE
DRAWN	LARRY	2/3/69
CHK'D	GAG	6-2-69
APP'D		

MODEL 129
C-140-15033 ISSUE B
SHEET NO. 1 OF 1 SHEETS


-15V
R4 2.4K
R5 51
R9 2.4K
R10 47
R14 2.4K
R15 43
R20 2.4K
CR4
CR5
CR8
MICON CONNECTOR
A
CR1
Q1
Q4
Q5
C1 220 Pf
C2 220 Pf
C3 220 Pf
R1 51 1/8 W
R6 300 1/2 W
R11 240 1/2 W
R16 200 3W W. W.
VARIABLE NEGATIVE SUPPLY
MICON CONNECTOR
B
CR2
Q2
Q3
Q6
C5 220 Pf
C6 220 Pf
C7 220 Pf
CR3
CR6
CR7
R2 51 1/8 W
R3 2.4K
R7 51
R8 2.4K
R12 47
R13 2.4K
R17 43
R18 2.4K
-15V
VARIABLE NEGATIVE SUPPLY
-15V

P.C.B. 400



REVISIONS						
	REVISION	DATE	DRAWN	CHK'D	APP'D	OBD
A	ORIGINAL RELEASE	—	—	—	—	—
B	R28 WAS 510 Ω ½W, R24 WAS 120 Ω	7-30-69	DS	GAG		

D-140-15039 B

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. CIRCLED NUMBERS INDICATE MATCHED PAIRS.
2. ALL DIODES ARE MATCHED PAIRS: 374-11797
3. ALL TRANSISTORS ARE MATCHED PAIRS 663-15300
4. ALL RESISTORS ARE IN Ω (OHMS) ¼ W 5% CARBON
5. ALL CAPACITORS ARE IN PF (PICO-FARADS), AND HAVE FOIL LEADS
6. REFERENCE DRAWINGS:
   P.C.B. FAB 400-15037
   P.C.B. ASSY 402-15038

ITEM NO	PART NO.	DESCRIPTION	QTY

PROPRIETARY INFORMATION

NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.

MATERIAL LIST

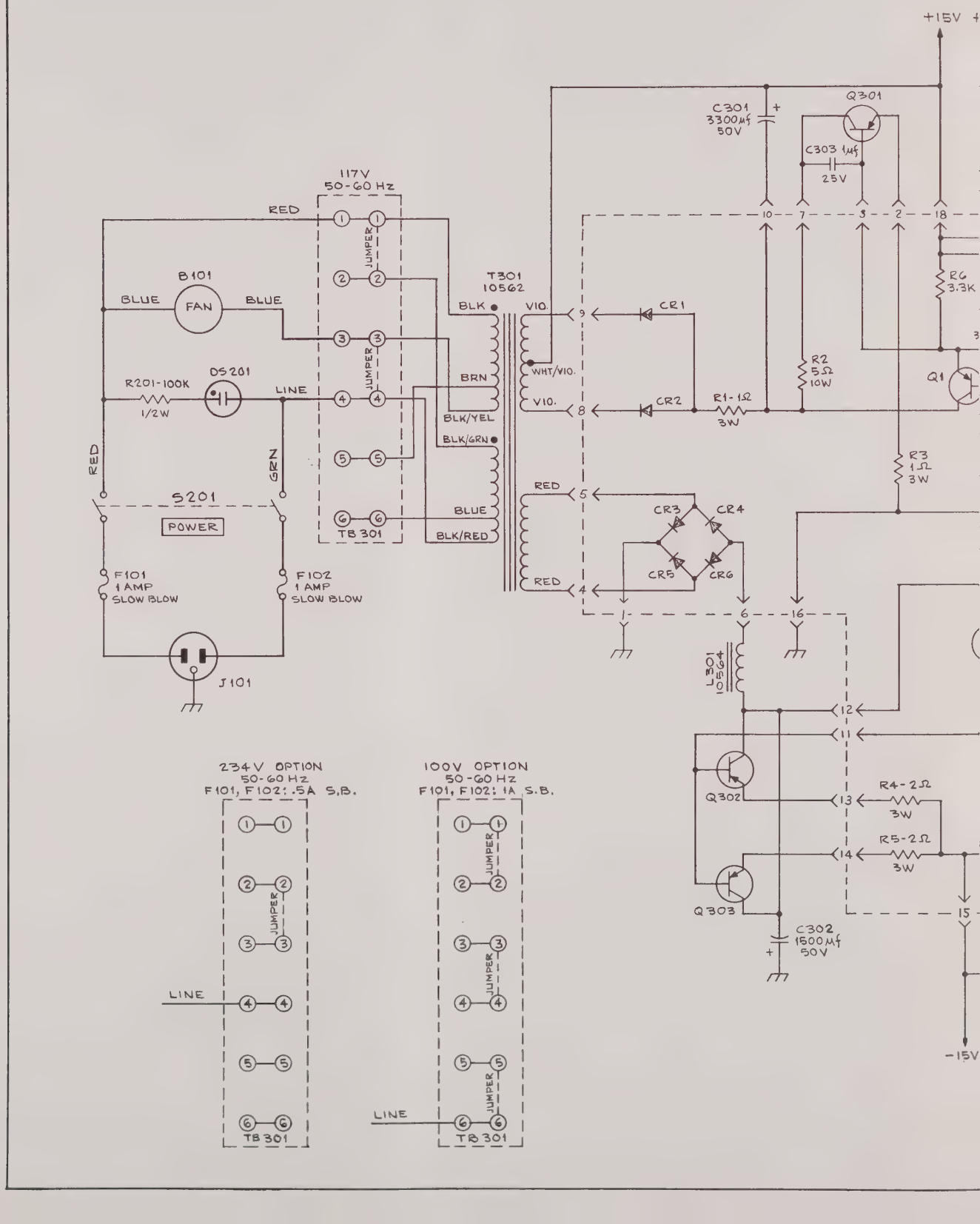
UNLESS OTHERWISE SPECIFIED
SCALE
FRACTIONAL ± 1/64
DECIMALS ± .XX = .03
± .XXX = .010
ANGLES ± 1°
DO NOT SCALE DRAWING
FINISH

402-15038	—	129	USED ON

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE
SCHEMATIC
OUTPUT BOARD

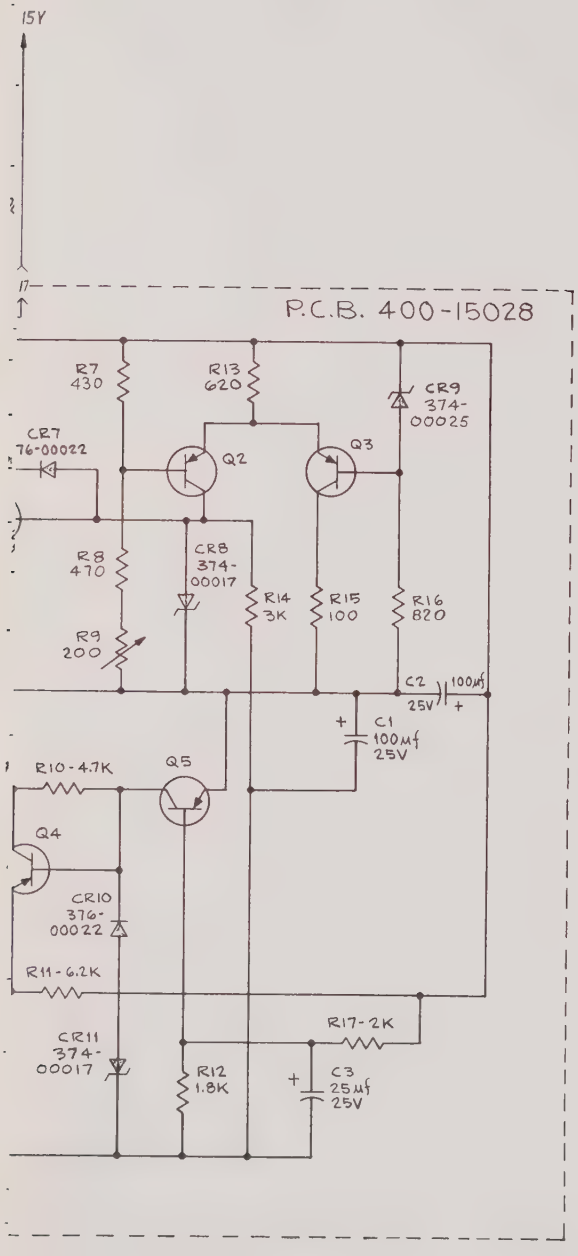
	INITIALS	DATE	MODEL 129
DRAWN	Larry	4/22/68	D-140-15039 B
CHK'D	GAG	6-2-69	
APP'D			SHEET NO. 1 of 1

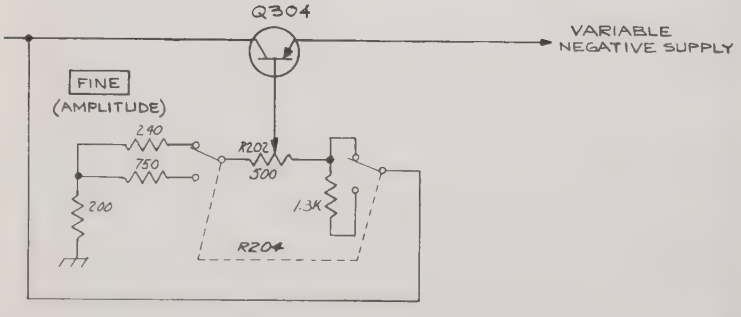

+15V
C301
3300µf
50V
Q301
C303 1µf
25V
117V
50-60 Hz
RED
JUMPER
B101
BLUE
FAN
BLUE
T301
10562
BLK
VIO.
CR1
R6
3.3K
R201-100K
1/2W
DS201
LINE
BRN
WHT/VIO.
VIO.
CR2
R1-1Ω
3W
R2
5Ω
10W
Q1
BLK/YEL
BLK/GRN
R3
1Ω
3W
RED
GRN
S201
POWER
RED
CR3
CR4
CR5
CR6
BLUE
BLK/RED
TB 301
F101
1 AMP
SLOW BLOW
F102
1 AMP
SLOW BLOW
J101
L301
10564
Q302
R4-2Ω
3W
R5-2Ω
3W
Q303
C302
1500µf
50V
-15V
234V OPTION
50-60 Hz
F101, F102: .5A S.B.
100V OPTION
50-60 Hz
F101, F102: 1A S.B.
LINE
LINE

D-15030 B

REVISIONS

ISSUE	REVISION	DATE	DRAWN	CHK'D	APP'D	ECO
A	ORIG. RELEASE	~	~	~	~	~
B	1.3K WAS 1.1K ON AMPLITUDE CONTROL	7-29-69	GAG	DS		





NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS ARE IN OHMS, 1/2W, 5%.
2. R12 & R17 ARE METAL FILM, 1%.
3. ALL DIODES ARE IN4005.
4. ALL TRANSISTORS ON BOARD ARE 11725.
5. ALL TRANSISTORS OUTSIDE BOARD ARE 11705.
6. REF. DWGS:
   P.C.B. FAB. 400-15028
   P.C.B. ASSY 401-15029

ITEM NO	PART NO	DESCRIPTION	QTY

MATERIAL LIST

PROPRIETARY INFORMATION
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.

UNLESS OTHERWISE SPECIFIED
SCALE NONE
FRACTIONAL ± 1/64
DECIMALS ± .XX = 03
± .XXX = 010
ANGLES ± 1°
DO NOT SCALE DRAWING
FINISH NONE

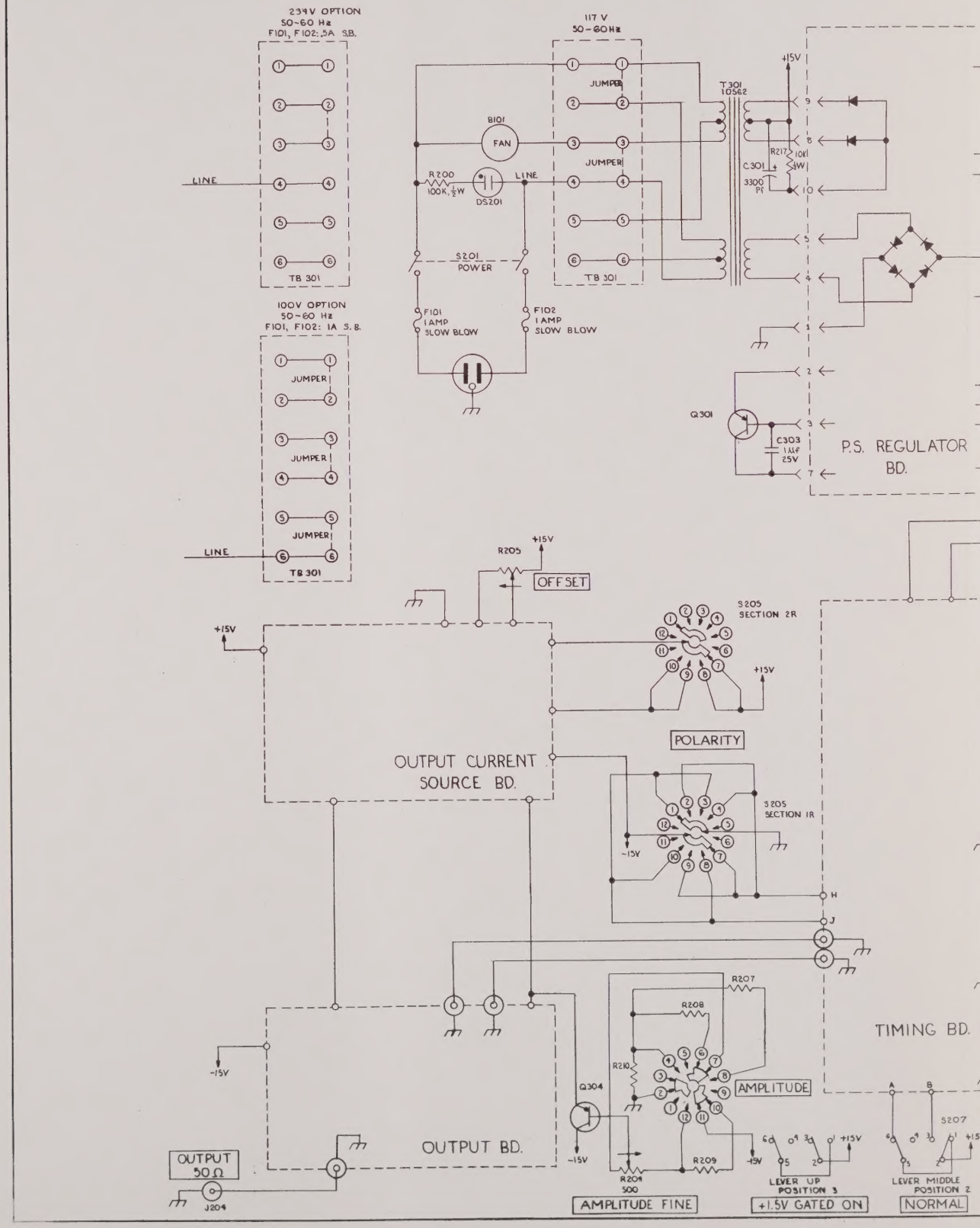
NEXT ASSY 401-15029
REQ'D —
USED ON G.T.I.

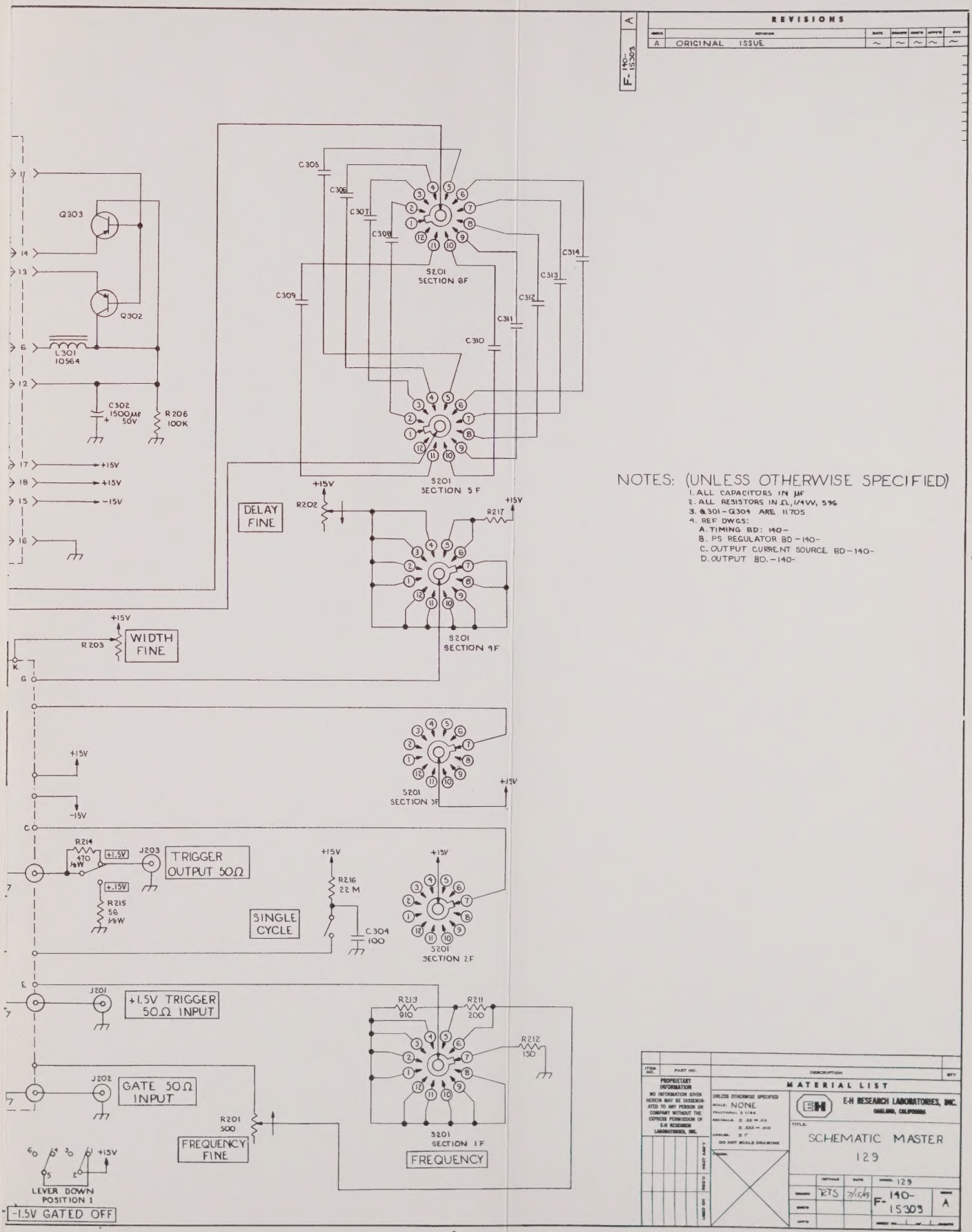
E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE
SCHEMATIC, P.S. REGULATOR BD

	INITIALS	DATE
DRAWN	G.L.	2/26/69
CHK'D		2-27-69
APP'D		

MODEL 129
D- 140-15030 B
SHEET NO 1 OF 1 SHEETS


234V OPTION
50-60 Hz
F101, F102: .5A S.B.
LINE
TB 301
100V OPTION
50-60 Hz
F101, F102: 1A S.B.
JUMPER
LINE
TB 301
117 V
50-60Hz
JUMPER
JUMPER
TB 301
B101
FAN
R200
100K, ½W
DS201
LINE
S201
POWER
F101
1 AMP
SLOW BLOW
F102
1 AMP
SLOW BLOW
T301
10562
+15V
R217
10K
1W
C301
3300
Pf
Q301
C303
1 Mf
25V
P.S. REGULATOR
BD.
R205
+15V
OFFSET
+15V
S205
SECTION 2R
+15V
POLARITY
OUTPUT CURRENT
SOURCE BD.
S205
SECTION 1R
-15V
H
J
R207
R208
R210
Q304
AMPLITUDE
TIMING BD.
-15V
OUTPUT BD.
-15V
R209
+15V
OUTPUT
50 Ω
J204
R204
500
AMPLITUDE FINE
LEVER UP
POSITION 3
+1.5V GATED ON
S207
LEVER MIDDLE
POSITION 2
NORMAL


REVISIONS
A ORIGINAL ISSUE
F-140-15309 A
Q303
Q302
L301
10564
C302
1500MF
50V
R206
100K
+15V
+15V
-15V
C305
C306
C307
C308
C309
C310
C311
C312
C313
C314
S201
SECTION 8F
S201
SECTION 5F
DELAY
FINE
R202
R217
S201
SECTION 9F
R203
WIDTH
FINE
S201
SECTION 3F
R214
470
1/2W
J203
TRIGGER
OUTPUT 50Ω
R215
56
1/2W
SINGLE
CYCLE
R216
22 M
C304
100
S201
SECTION 2F
J201
+1.5V TRIGGER
50Ω INPUT
J202
GATE 50Ω
INPUT
R213
910
R211
200
R212
150
R201
500
FREQUENCY
FINE
S201
SECTION 1F
FREQUENCY
LEVER DOWN
POSITION 1
-1.5V GATED OFF
NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL CAPACITORS IN μF
2. ALL RESISTORS IN Ω, 1/4W, 5%
3. Q301-Q304 ARE 11705
4. REF DWGS:
A. TIMING BD: 140-
B. PS REGULATOR BD-140-
C. OUTPUT CURRENT SOURCE BD-140-
D. OUTPUT BD.-140-
MATERIAL LIST
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